AHAS - Aviation Hazard Awareness System

Design and Flight Testing of a Prototype AWIN System for Transport Aircraft

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Presentation Outline

- Introduction
- Background
- Flight Experiment Configuration
- Flight Test Results
- Simulation Experiments
- Conclusions

WxAP/AWIN/AHAS Milestones

- Milestone 11: Initial AHAS Flight Evaluation
  - Completed on ARIES 2002 with AHAS
- Milestone 14: AHAS Flt Eval w/ Cockpit Display
  - Scheduled for 2003 Deployment – Cancelled due to ARIES structural concerns
  - Milestone declared satisfied by earlier flight tests + simulation experiments

Aviation Hazard Awareness System (AHAS) Background

AvSP / Weather Accident Prevention / Aviation Weather INformation

- Based on EWxR and AWARE Cooperative Research Agreements (CRAs)
  - Negotiated between NASA and Rockwell Science Center (now Rockwell Scientific) and involving Rockwell Collins
  - AWARE: Aviation Weather Analysis and Reporting Enhancements
    - Originally intended as a General Aviation (GA) pre-flight briefing tool
    - Technology evaluated by Rockwell for AWARE Dispatcher tool for airline customers
  - EWxR: Enhanced Weather Radar
    - Combines airborne weather radar with datalinked information
    - Flight tested on Rockwell and NASA aircraft
    - Flown on NASA B-757 Airborne Integrated Research Experiment System (ARIES) in 2000 & 2002
- AHAS is a NASA-sponsored program conducted jointly by Rockwell Scientific, Rockwell Collins, and NASA
  - Combines EWxR and AWARE CRA technologies into an in-flight weather analysis and pilot decision aiding tool

Aviation Hazard Awareness System (AHAS) Background

AvSP / Weather Accident Prevention / Aviation Weather INformation

- **AHAS is an enhanced weather analysis tool, integrating text-based and graphical weather data for superior situational awareness in the context of a specific mission and equipment profile**
- **Initial flight evaluation on NASA B-757 Airborne Integrated Research Experiment System (AIRES) in FY-2002**
  - First-generation prototype AWIN system
  - Evaluation by researchers - no cockpit display
- **AHAS Tactical Mode: Enhanced Airborne Weather Radar**
  - Derived from EWxR CRA technologies
  - Pilot can select combinations of Airborne WxR, NEXRAD, Attribute Data
  - Real-time hazard assessment.
  - Radar data collection for additional post-flight processing
- **AHAS Strategic Mode: Moving Map Display**
  - Derived from AWARE CRA technologies
  - Real-time hazard analysis on datalinked weather information
  - Strategic display of flight-path relevant weather hazards
- **AHAS Decision Aids:**
  - Weather Hazard Alerting & weather conflict prediction (EWxR).

Why weather decision aids?

Complexity of information: Pilots must first parse & translate information from multiple airborne and off-aircraft sources, including cryptic WMO codes, then draw on training and experience to interpret.

Volume of information: Pages of text are the norm for pre-flight briefing. Future proliferation of graphical weather products may increase difficulty of monitoring relevant weather.

Reduction in workload/training: Pilots receive training in meteorology; Decision aid can reduce reliance on training.

Why weather decision aids?

AHAS is designed to benefit pilots (or dispatchers) who, due to cognitive overload, may not absorb and retain all flight-critical weather information from the vast (cryptic) stream of data they are legally required to review…

KTRM 022352Z 12006KT 25SM FEW200 SCT250 25/03
A2988 RMK SLP117 10261 20219 56015
KBUO 022346Z 29009KT 7SM SKC 18/14 RMK MAX 68
NOSPECI
KRIV 022355Z 28006KT 3SM HZ FEW000 19/11 A2995
RMK SLP133 HZ FEW000 56008
KRAL 022346Z 28012KT 7SM SKC A2993
KONT 022346Z 22008KT 6SM HZ FEW000 23/08 A2993
RMK HZ FEW000
KNXP 022355Z 00000KT 7SM FEW200 20/02 A2995
RMK SLP121 8/001 T02000022 10200 20128 56019

Why weather decision aids?

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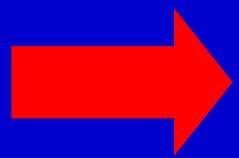
WHAT YOU GET NOW...

- TAFs
- METARs
- FAs
- AIRMETs
- SIGMETs
- NOTAMs
- PIREPs
- Winds Aloft
- NEXRAD images
- on-board WXR
- ...



WHAT YOU REALLY NEED TO KNOW ...

Can I safely complete my mission without encountering weather hazards?

AHAS/AWARE Decision Analysis

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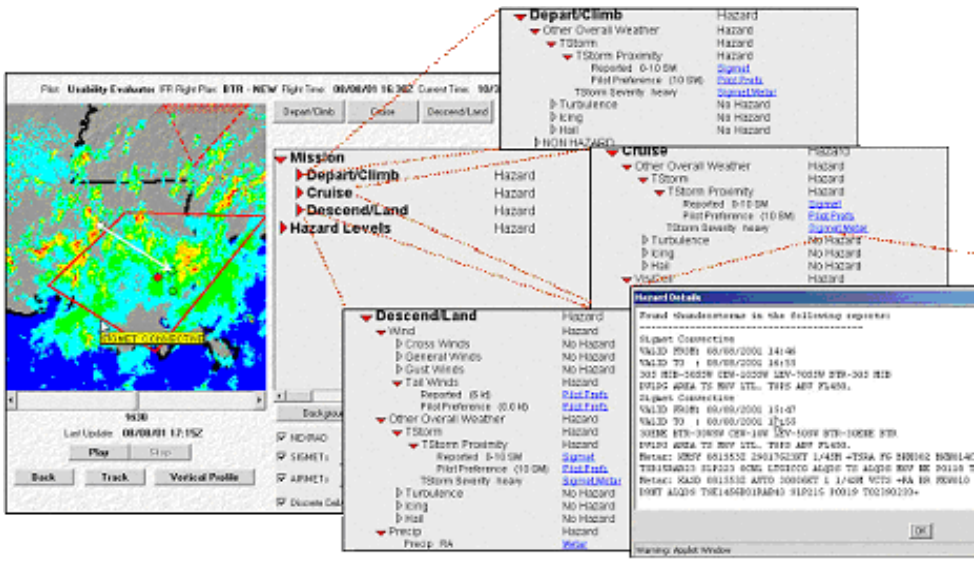
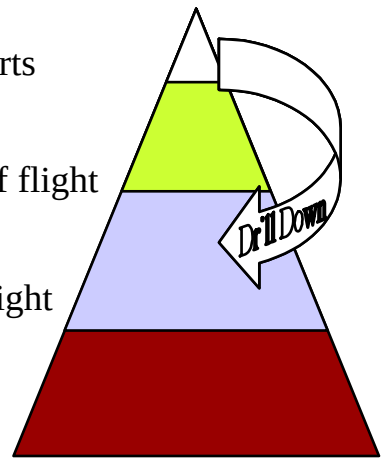
- Information filtering.
- Applies user/equipment constraints.
- User still has access to raw data.



Filtered to:	Number of reports:
Actual Alerts	5
Location of flight	16
Time of Flight	5515
Full Day	25410



AHAS Tactical WxR/NEXRAD Data Correlation/Fusion

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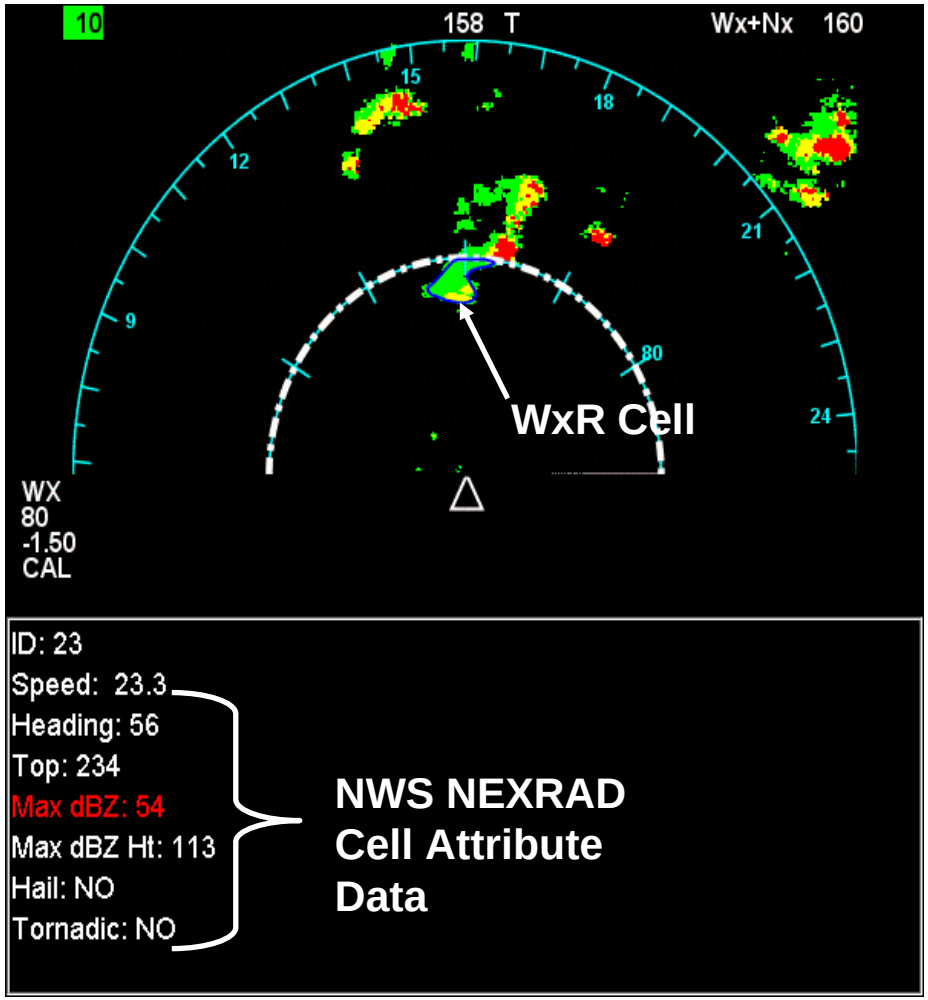

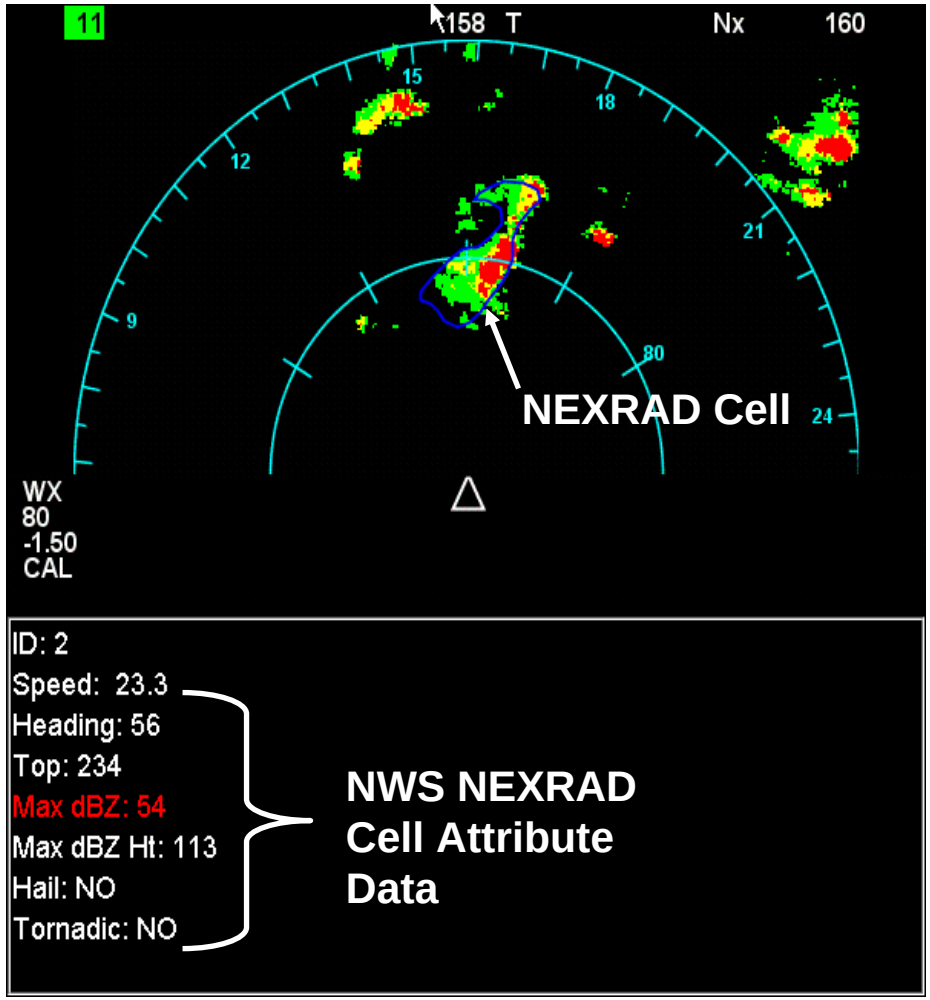

AHAS/EWxR Decision Aids

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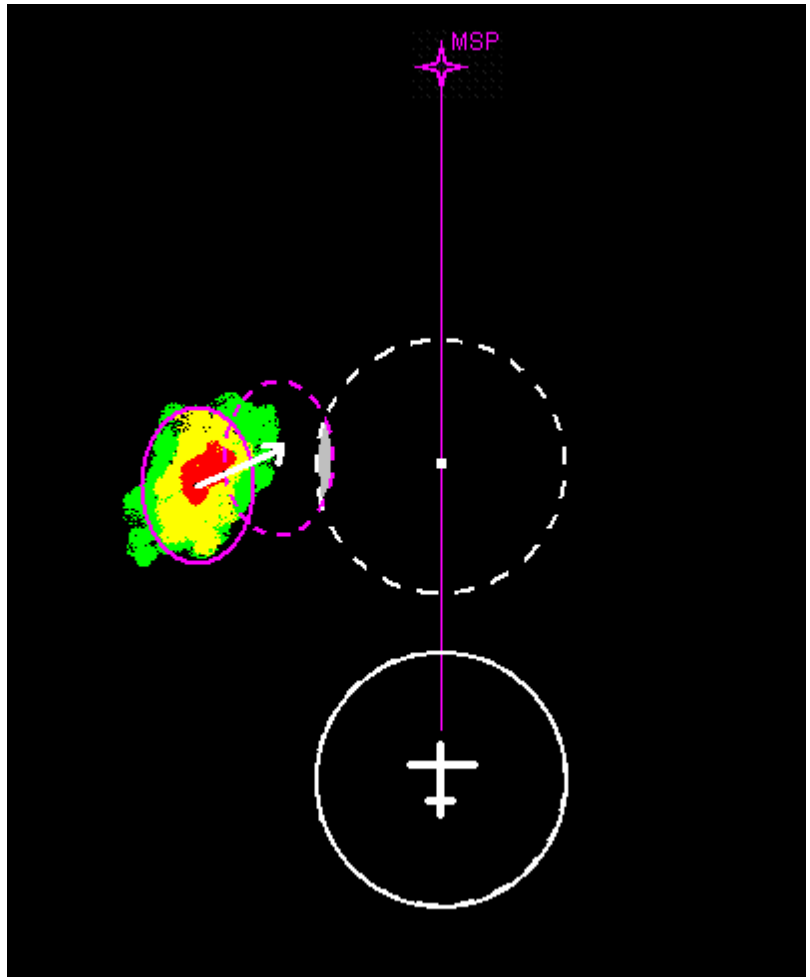
- Weather Hazard Avoidance and Flight Path Impact Prediction algorithm automatically determines hazardous regions along flight plan.
- Operates in real time with dynamic data.



Airborne Hazard Avoidance System (AHAS)
Strategic Display

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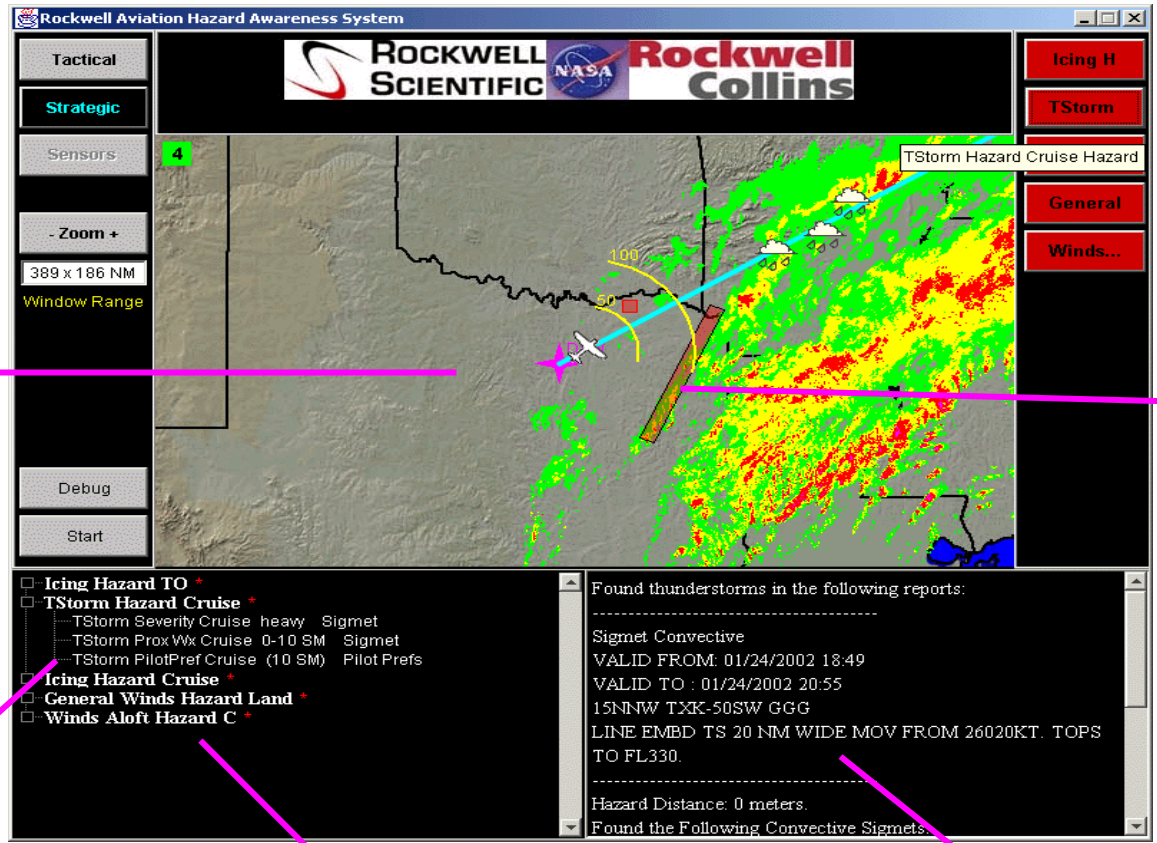

Modes & Pull-Down Menus

Alerts

NEXRad with Overlay of Other Weather Products

Textual SIGMET Rendered Graphically

Advisories are Based on Pilot & Aircraft Capabilities

Decision Analysis

SIGMET Text

Airborne Hazard Avoidance System (AHAS)
Tactical Display

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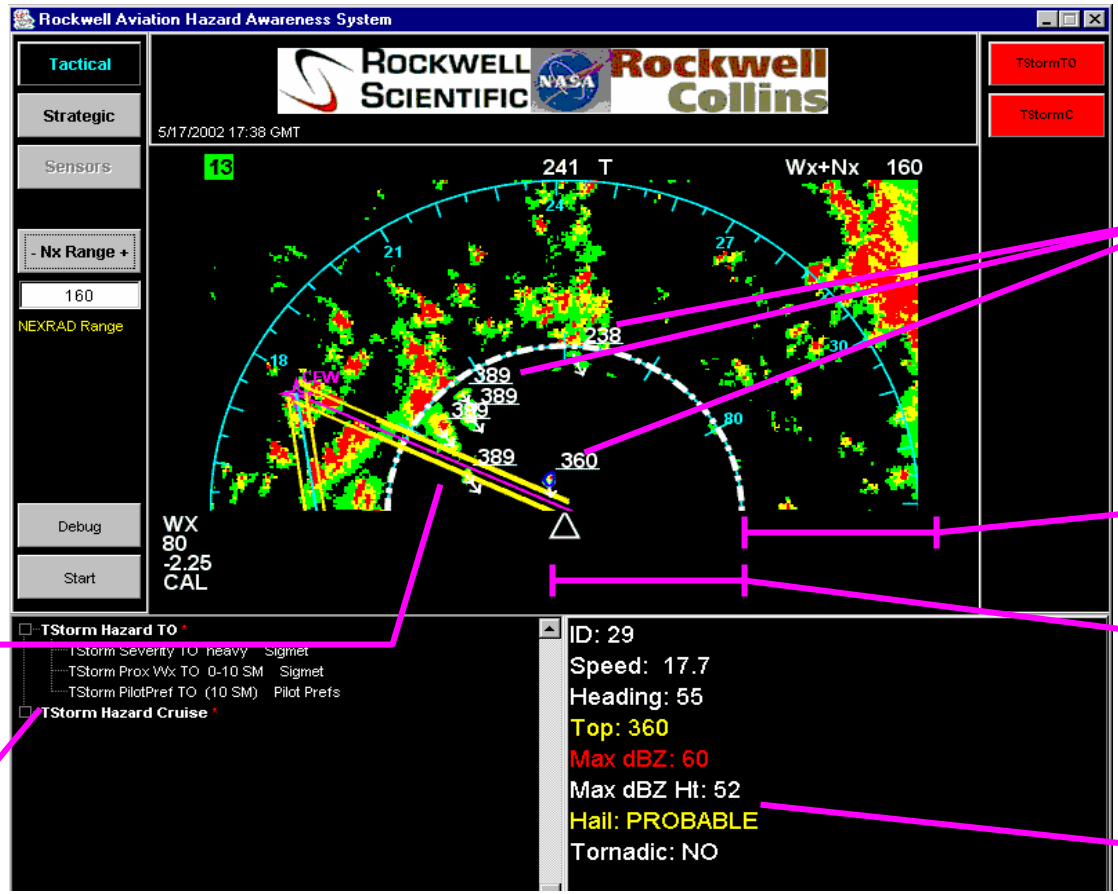

Modes & Pull-Down Menus

Alerts

Storm Top Altitudes

NEXRad

Flight Plan Impact

On-Board WxR

Explanation of Alerts

Storm Data from NEXRad

AHAS/EWxR on WxAP Integrated Flight Experiments

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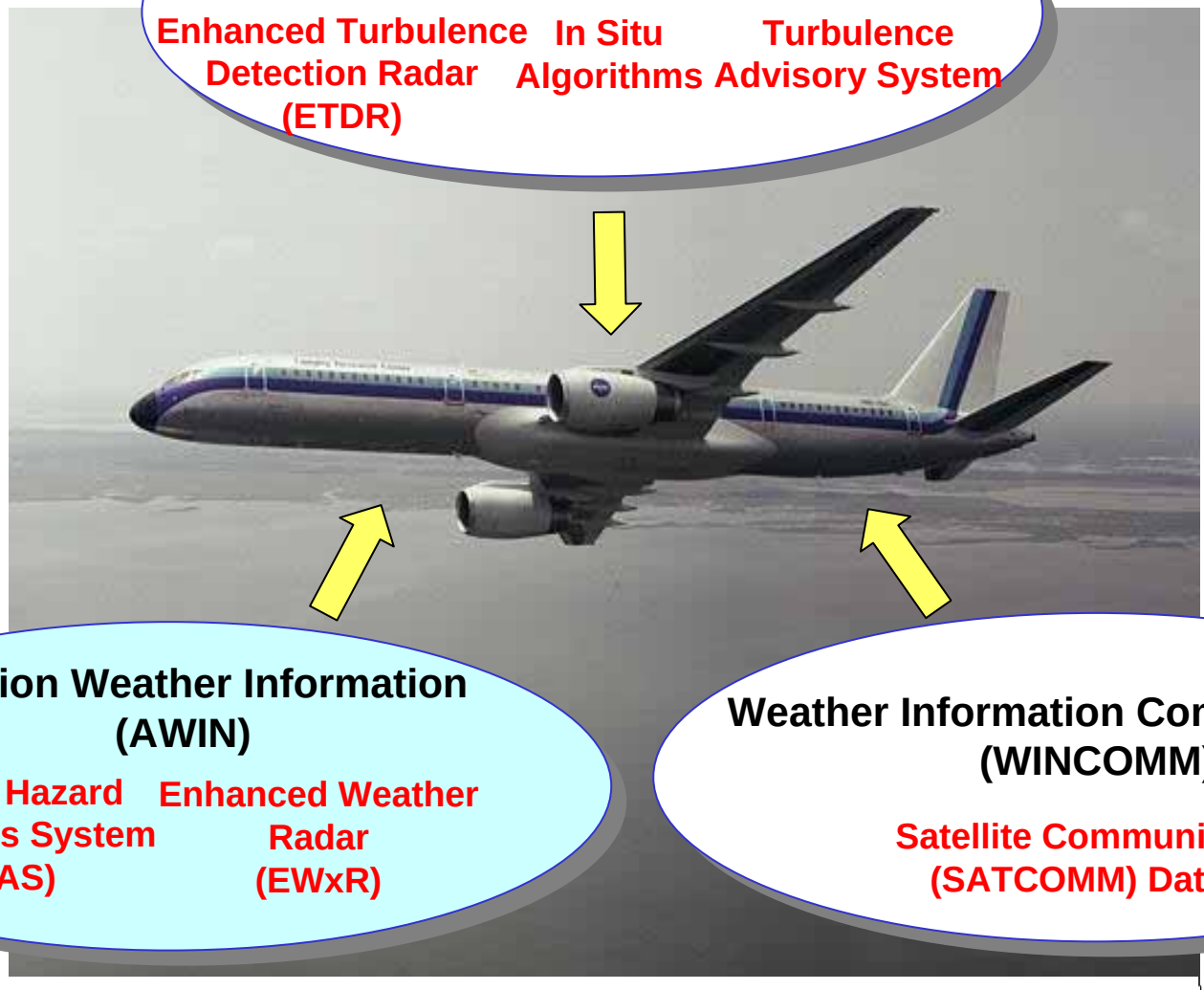
Turbulence Prediction & Warning Systems (TPAWS)

- Enhanced Turbulence Detection Radar (ETDR)
- In Situ Algorithms
- Turbulence Advisory System



Aviation Weather Information (AWIN)

- Aviation Hazard Awareness System (AHAS)
- Enhanced Weather Radar (EWxR)

Weather Information Communications (WINCOMM)

- Satellite Communication (SATCOMM) Datalink

AHAS/EWxR ARIES Installation

AWIN Modifications at TTA1 Pallet

AHAS FY-02 System Block Diagram

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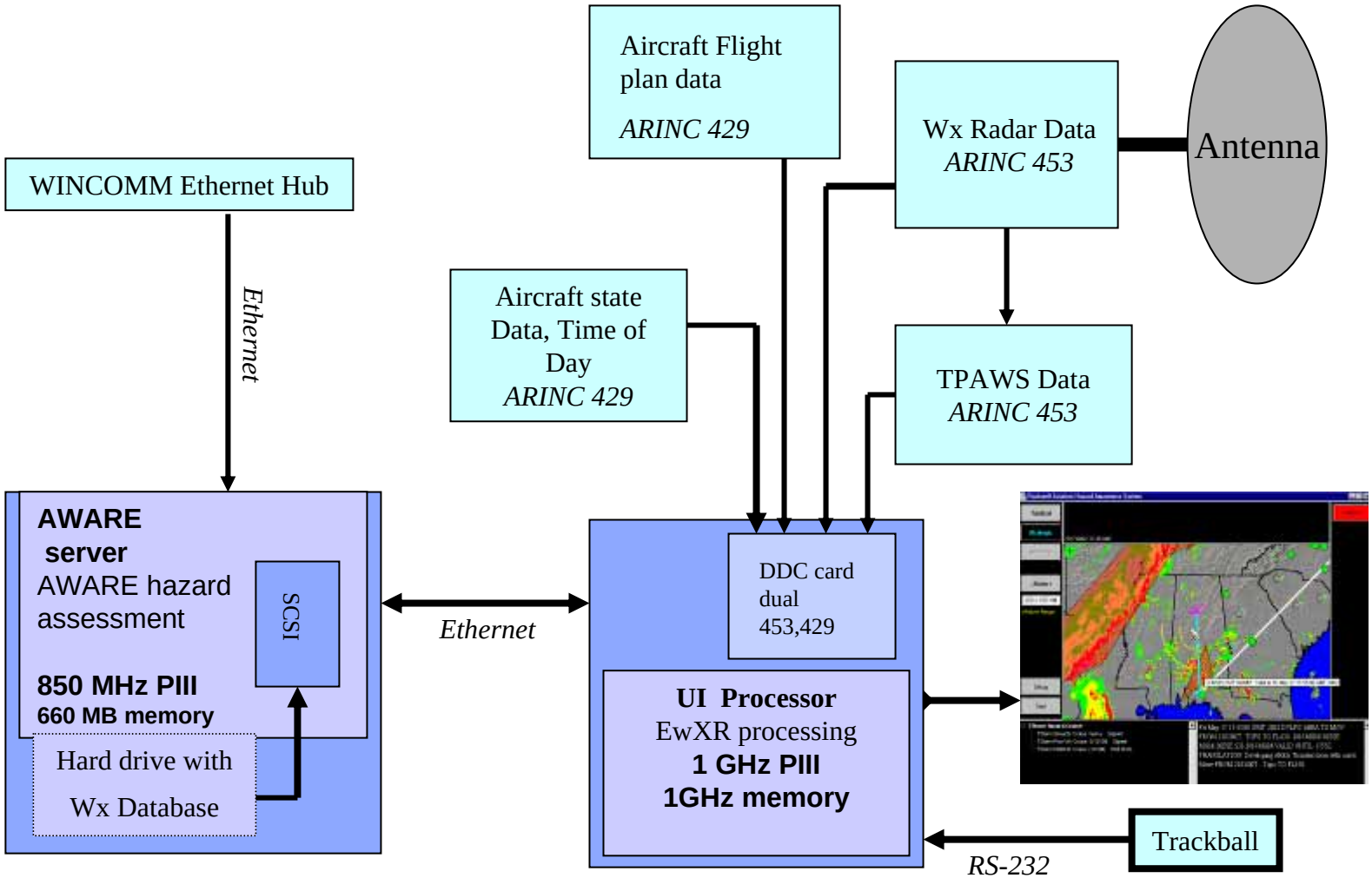

AHAS/EWxR Accomplishments

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- Installed AHAS on NASA B-757 ARIES
- Conducted flight experiments to collect weather, aircraft, and radar data and assess overall system performance using research displays in the aft cabin of the B-757
- AHAS and EWxR operated on 15 flights in 2002 and extensive data was collected
- EWxR tested by Rockwell on Sabreliner
- Verified data-linked storm-top information, turbulence indications, and SIGMET hazard areas using airborne weather radar, in situ information, visual, and meteorological observations

AHAS/EWxR Accomplishments (Continued)

- Evaluations support the utility of the AHAS system in increasing strategic and tactical situational awareness of weather hazards via successful demonstration of:
  - Correlation/Data fusion of airborne and ground-based weather information.
  - Automated Hazard Assessment and Flight Path Impact Decision Aids.
- Simulation experiments were conducted to further evaluate and refine AHAS

Rockwell Sabreliner Flight Test

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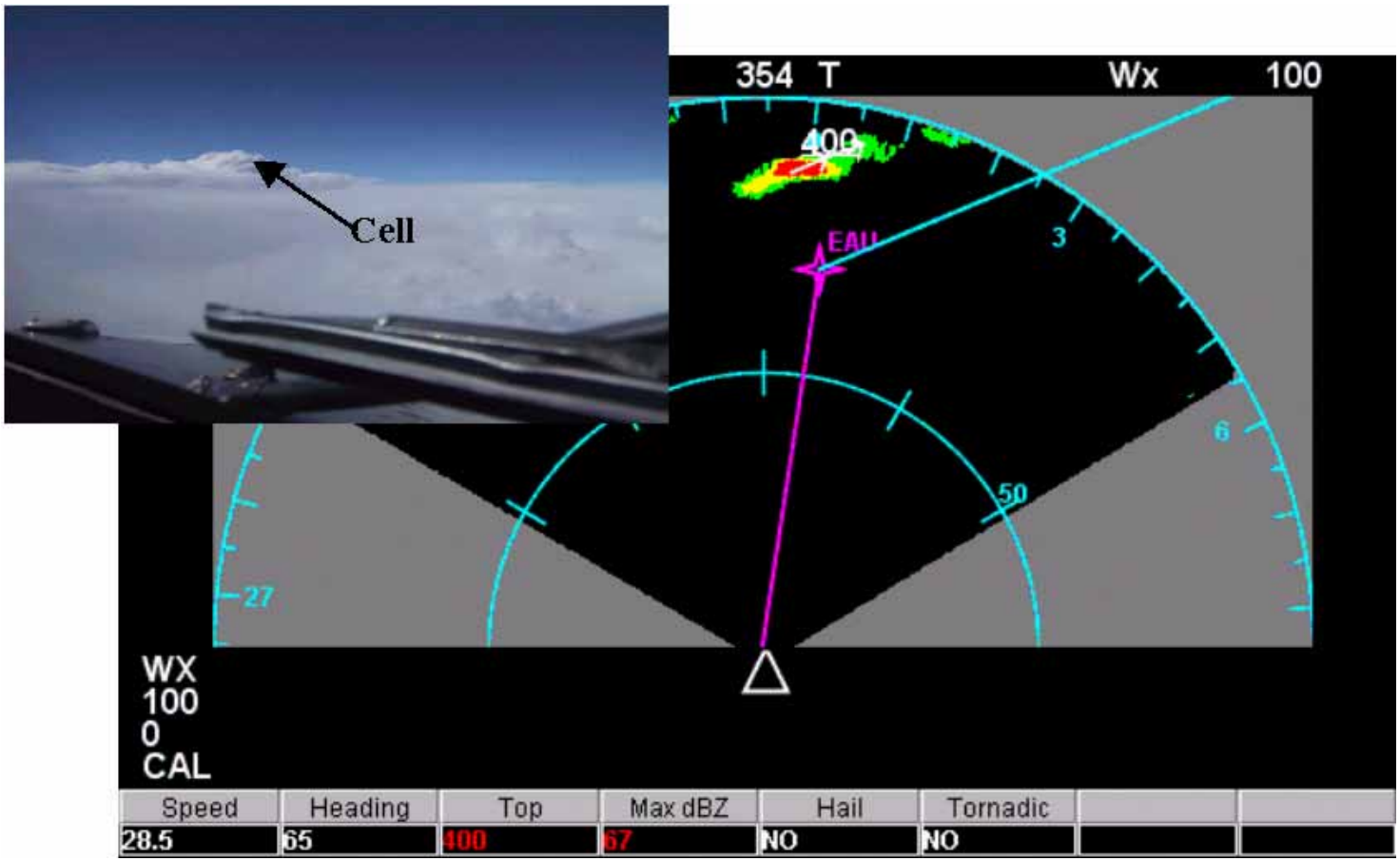

Hazard Assessment - September 5, 2002

NASA ARIES AHAS/EWxR Flight Tests

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Flight Path Impact Prediction

May 17, 2002

Simulation Experiment Summary

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- 2004 - The NASA Aviation Weather Information Display Study (AWIDS) project used AHAS to support and conduct simulation experiments at the University of Iowa
- Software and hardware upgrades incuded
  - Cockpit Display enhancements for simulation
  - Computer Upgrades
  - Extend Client/Server Architecture
- Experiment Objectives
  - Piloted assessment of AHAS integrated weather information (NEXRAD & airborne WxR) in simulation.
  - Usability feedback on AHAS display formats

AHAS Summary

- AHAS Benefits
  - AHAS is an enhanced weather analysis and display tool, integrating text-based and graphical weather data (both data-linked and airborne sensor-based) in the context of a specific mission and equipment profile
  - AHAS uses decision aid tools to assess and automatically alert pilot to relevant weather hazards
  - Displays of datalinked weather information in both strategic (map) and tactical (track-up, combined with airborne weather radar) were developed and shown to work in real-time.

Conclusions

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- **AHAS is a prototype AWIN system**
  - Builds on technologies developed under AWARE and EWxR Cooperative Research Agreements
  - Supports AWIN research on cockpit use of graphical weather products and decision aiding by intelligent analysis of weather information
  - Flight tests on NASA B-757 ARIES in FY-02 supported utility and continued development
  - Piloted simulations conducted in FY-04/5
  - Applicability to ground and airborne users in both Transport and General Aviation.